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ABSTRACT

This review examines the definition, measurement, and correlates of computer anxiety as provided in available research. The concept of computer anxiety reflects an anxiety state, rather than an anxiety trait, thus rendering it susceptible to change over time. Computer anxiety is similar in nature to math anxiety and test anxiety. Two approaches to anxiety measurement exist. One focuses upon the direct development of an index of computer anxiety which is then related to other variables; the other involves indirect responses from subjects regarding their fears or attitudes toward computers derived from items on a survey of computer usage. Some generalizations regarding state-of-the-art in computer anxiety measurement are: The main approach has been use of self-report measures; a basic model for several instruments has been developed in connection with the State-Trait Inventory; Likert scale formats are frequently used; and items are developed from some rational definition of computer anxiety. The current research suggests the concepts of computer anxiety are difficult to measure validly, but what is measured can be done reliably. Potential correlates of computer anxiety include gender, state-trait anxiety, and hemisphericity. (DWH)

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COMPUTER ANXIETY: DEFINITION, MEASUREMENT, AND CORRELATES

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ABSTRACT

This review examines the definition, measurement and correlates of computer anxiety as provided in available research to date.

A selected review of the general anxiety construct and its measurement provides a framework for considering computer anxiety. Test anxiety and math anxiety are discussed briefly as specific anxiety manifestations with potential similarities, particularly as they relate to the educational context. Five studies are identified and discussed for their contributions to an understanding of the definition, measurement practices, and correlates of computer anxiety. It is clear from this preliminary review that more work must be done to determine if computer anxiety is a valid psychological construct and, if it is, how it should be defined, measured, and correlated with other known variables.

BACKGROUND AND DEFINITIONS

Introduction

The introduction of changes of a technological nature in many societies often leads to concern about how persons will react both cognitively and emotionally to such changes. While often accepting the change on a rational basis, some individuals express concern and fear about the impact of such changes on their lives. The emergence of computers, particularly the introduction of the personal and professional microcomputers, has led to a concern about the emotional reaction to them. One example of this concern is evidenced in the advertising introducing the Macintosh computer. Advertisements picture the computer along with the expression "High Technology without High Anxiety." As a consequence of this perceived relationship between the computer and emotional reactions to it, several individuals have created the concept of "computer anxiety."

The purpose of this paper is to provide background for a discussion of contemporary views on the nature, measurement, and correlates of the concept "computer anxiety." The paper is organized so that a selected review of the general concept of "anxiety" is presented initially in order to provide a framework for considering "computer anxiety." Test anxiety and math anxiety are discussed briefly as specific anxiety manifestations with potential similarities, particularly as they relate to the educational context. Several definitions of "computer anxiety" are then reviewed, measurement practices analyzed, and correlates identified from several studies of computer anxiety available in the literature.

The Nature of Anxiety

Anxiety as a psychological construct is, by and large, a twentieth century phenomenon. Spielberger (1966) traces its early history to Freud's identification of "angst" as a discrete clinical syndrome in 1894, through animal studies in the 1940's, to four landmark publications in 1950: May's The Meaning of Anxiety, Mowrer's Learning Theory and Personality Dynamics, Hoch and Zubin's edited volume Anxiety, and Dollard and Miller's Personality and Psychotherapy.

May (1950) provides an analysis of historical and cultural contributors to the fashioning of anxiety as a characteristic symptom of modern times, including the pressure for social change produced by rapid scientific and technological advances. He suggests that, because of dangers and ethical problems related to the experimental manipulation of human anxiety manifestations, there would probably never be an experimental psychology of anxiety.

Contrary to May's prediction, the number of anxiety studies, both experimental and correlational, increased steadily in the 50's and 60's to the point where, in the years 1960-1963 alone, the percentage of anxiety studies reported in Psychological Abstracts increased eight times over what it had been in 1930. Spielberger (1966) estimates that approximately 3,500 anxiety-related publications appeared in the research literature between 1950 and 1966. The trend has continued to the present day.

Despite the large amount of anxiety research reflected in the literature, the construct still defies theoretical and methodological concensus. If the study of anxiety is characterized by any one thing it is the lack of uniformity regarding its definition, cause(s) and measurement.

Several researchers have attempted to synthesize the numerous definitions and theories of anxiety profferred in the literature. Two such syntheses are briefly summarized here, as they shed light on the constructs that serve as the basis for this paper.

Epstein (1972) suggests that all of the definitions he analyzed allow a general description of anxiety as a "state of diffuse arousal following the perception of threat, or alternatively, as unresolved fear." (p.334) He concludes that anxiety can best be described as a concept composed of three basic sources or conditions, each having a unique "feeling state" associated with it.

The first and most basic source of anxiety in Epstein's scheme is PRIMARY OVERSTIMULATION. It involves frantic feelings of being overwhelmed or bombarded with stimulation to the upper limits of tolerance. It is often associated with a feeling of pain. The typical reaction to primary overstimulation might be, "Stop it, I can't stand it anymore." (p.303)

COGNITIVE INCONGRUITY is associated with situations that involve a discrepancy between an individual's cognitive plan or expectancy and reality, and the subsequent failure to form a predictive model or plan to cope. Confusion, disorientation, disorganization, and personality disintegration are the feeling states associated with cognitive incongruity.

Cognitive Incongruity is one of the contributing factors to RESPONSE UNAVAILABILITY, an anxiety condition that occurs when the object producing the arousal is unknown, or when a waiting period is required before a response can be made, or when there is conflict between opposing response tendencies, or when the response recognized as necessary is not in the

repertory of the individual. Helplessness is the feeling state resulting from response unavailability. A key issue in Epstein's synthesis is that the anxiety-provoking threat may be perceived only and not necessarily reality-bound.

Philips, Martin, and Meyers (1972) suggest that theories of anxiety converge on a number of points including the following:

(1) There are three types of indicators of anxiety: behavioral, physiological, and phenemenological. Discrepancies perceived between these indicators may be partially attributed to defensiveness.

(2) Anxiety is a two-part concept. "Trait", "neurotic," or "chronic" anxiety is a general proneness to be anxious and is dispositional or personality related. "State," "objective," or "situational" anxiety is a direct function of a particular stressful condition and is located in a particular point in time.

(3) Anxiety is the result of psychological stress, brought about by "threatened deprivation of an anticipated satisfaction." An anxiety reaction to stress can occur as a result of uncertainty associated with external or environmental factors as well as internal or cognitive factors.

(4) Anxiety typically occurs in conjunction with other reactions to stress — e.g., other affects, defensiveness, coping reactions.

(5) The consequences of anxiety are complex and interactional in nature, and depend on the demands of the situation. Although they are usually negative and debilitating, there are times when anxiety can be helpful, facilitating adaptation, adjustment, and performance (Philips, Martin and Meyers, 1972, p. 412).

The trend to define anxiety as a two-dimensional phenomenon seems to

be a fruitful one for purposes of research. Freud again provided the impetus in this direction when he conceptualized anxiety as a signal indicating the presence of a danger situation, and differentiated between objective anxiety, the source of which was a perceived danger from the external world, and neurotic anxiety, whose source of danger was internal impulses (Spielberger, 1966, p.9).

In factor analysis studies, Cattell and Scheier (1958, 1961) identified two anxiety types which they called "trait" anxiety and "state" anxiety. Trait anxiety was defined as a unitary, relatively stable and permanent personality characteristic. State anxiety was conceptualized as a transitory condition which fluctuated over time and treatment. Spielberger (1966) further refined and clarified the concepts by defining anxiety states (A-states) as "subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system" (p. 16-17); and an anxiety trait (A-trait) as "a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively nondangerous circumstances as threatening, and to respond to these with A-state reactions disproportionate in intensity to the magnitude of the objective danger." (p. 17)

Test Anxiety and Math Anxiety

Specific manifestations of anxiety that pertain to schooling or to school-related phenomena have captured the attention of educational researchers over the years (cf Ruebush, 1963). Two state-type anxieties in this category are test anxiety and math anxiety.

Test anxiety is defined as "a proneness to emit self-centered,

interfering responses when confronted with evaluative conditions." (Sarason, 1972, p. 383) It has been systematically studied as a specific manifestation of anxiety for approximately 30 years, beginning with Sarason and Mandler's research in 1952. Tryon (1980), in her review of the literature on the measurement and treatment of test anxiety, indicates that most current research suggests that test anxiety consists of two factors: worry and emotionality. Emotionality is unrelated to academic performance, whereas worry inhibits performance. Most currently used measures of test anxiety are derivations of the Test Anxiety Questionnaire (Mandler and Sarason, 1952). Small but significant negative correlations have been found by some researchers between test anxiety scores and college GPA's, course grades, and various aptitude and achievement tests (cf Tryon, 1980).

Mathematics anxiety is described by researchers as ". . . [involving] feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematics problems in a wide variety of ordinary life and academic situations." (Richardson and Suinn, 1972, p. 551) The Mathematics Anxiety Scale (MARS) developed by Richardson and Suinn (1972) serves as the basic instrument for measuring this construct. Resnic, Viehe and Segal (1982) have identified three factors in math anxiety: evaluation anxiety, arithmetic computation anxiety, and social responsibility anxiety.

Math anxiety has been found to correlate with gender, prior math exposure, math achievement, trait anxiety, test anxiety, attitudes toward math, parents' and teachers' attitudes toward math (Betz, 1977).

Computer Anxiety

Recent studies suggest an addition to the array of specific anxiety manifestations discussed in the literature. Some psychologists and educators are proposing that "computer anxiety" is comparable to "test anxiety" and "math anxiety" as a situational manifestation of the general anxiety construct. These researchers imply that, like test and math anxiety, computer anxiety should be identified, measured, prevented and/or remediated in order to facilitate the successful education and socialization of its victims. How similar to other established anxiety traits is this relatively new phenomenon? Does it merit the attention of researchers and, if so, how do we determine its nature, measurement, and remediation?

Studies identified for purposes of this paper offer either operational definitions of computer anxiety or conceptual definitions derived from the general anxiety literature. Powers, et al. (1973) defined computer anxiety as changes on four established physiological measures: systolic blood pressure, diastolic blood pressure, heart rate, and electro dermal response. Powers investigated the relationship between user anxiety and the utilization of main-frame computer facilities, the effects of "hands-on" computer experience on anxiety levels of operators, and the effect of prior computer exposure on anxiety levels.

Jordan and Straub (1982) provided an operational definition of computer fear using a five-point Likert scale on the statement, "I am afraid to use computers." They conducted a discriminate analysis to identify differentiating individual characteristics between students indicating fear of using computers, those who indicated not being fearful,

and those who indicated a middle position.

.Researchers providing conceptual defintions of computer anxiety generally agree that the concept fits into the category of anxiety state rather than anxiety trait. Raub (1981) defines computer anxiety as "the complex emotional reactions that are evoked in individuals who interpret computers as personally threatening." (p.9) Using Spielberger's (1970, 1972) theory, Raub suggests that a greater proportion of A-trait people will exhibit A-state reactions when confronted with computers. Since anxiety states tend to be transitory, Raub hypothesizes that an individual's level of computer anxiety may change over time, but that the extent of that change may depend, at least in part, on his or her level of trait anxiety.

Maurer (1983) defines computer anxiety as "the fear and apprehension felt by an individual when considering the implications of utilizing computer technology, or when actually using computer technology. The individual is in the state (of computer anxiety) because of the fear of interaction with the computer, even though the computer possesses no immediate or real threat." (p.2)

Rohner and Simonson (1981) describe computer anxiety as "the mixture of fear, apprehension, and hope that people feel when planning to interact or when actually interacting with a computer. Because of this feeling, people who are computer anxious, when given the choice between using and not using a computer, often choose not to use." (Rohner & Simonson, 1981, p. 551)

Summary

This section reviewed briefly the nature of anxiety as a psychological construct. State anxiety and trait anxiety were identified as useful distinctions for purposes of anxiety measurement and research. Specific anxiety manifestations of particular relevance to educators, namely test anxiety and math anxiety, were briefly discussed in view of potential similarities to computer anxiety. Definitions of computer anxiety provided in the literature were then reviewed. Based upon these definitions, the following statements can be made:

1. Researchers have found that some individuals give evidence, either through physiological changes or responses on self-report measures, of a "fear" of using computers which they have termed "computer anxiety."

2. Researchers attempting to define computer anxiety suggest that it involves a complex array of emotional reactions including "fear", "apprehension", "hope", and "personal threat."

3. Emotional reactions described as computer anxiety may be triggered by consideration of the implications of utilizing computer technology by planning to interact with a computer, or by actually interacting with a computer.

4. Computer anxiety may occur even though the situation poses no immediate or real threat.

5. Computer anxiety is probably an anxiety state rather than an anxiety trait, and as such is susceptible to change over time.

THE MEASUREMENT OF COMPUTER ANXIETY

The characterizations and definitions of the general concept of anxiety and the specific concept of computer anxiety were the focus of the previous section. Accepting the concepts as noted, a major problem becomes one of how they are to be measured or assessed. A review of the literature on the measurement of computer anxiety reveals that it draws heavily upon prior research relating to the measurement of anxiety as a generalized personality trait. For this reason, this section has been divided into two parts. The first part reviews in a general way research on anxiety measurement, the second part reviews studies which have focused on developing a measure of computer anxiety.

Anxiety Measurement

Reviewing studies focusing upon the measurement of anxiety points out that there have been two general approaches to assessing the anxiety condition. Both psychological and physiological characteristics have been employed. The latter measurements have involved such assessments as blood pressure, pulse rate, respiration rate, galvanic skin response, palm sweating, and muscular action potential. Psychological measures have for the most part focused upon self-report instrumentation through inventories, scales, and questionnaires (Spielberger, 1972). The relationship between these two types of measures has been found not to be very strong (Sarason, 1960).

A rather comprehensive review of the development of self-report measures has been presented by Spielberger (1972). Because of their

relevance to studies on computer anxiety measurement, reference will be made here only to selected scales or inventories. Three scales will be described in brief form so as to provide a background for the reports on computer anxiety mesurement.

Anxiety measurement generally recognizes that the basic or generic scale development was that done by Taylor (1953) in the construction of the Manifest Anxiety Scale. This instrumentation was developed to serve as a measure of drive in connection with Hullian learning theory. As such, it was not intended to be a direct measure of anxiety but it has served as a criterion against which many other such measures have been validated. The scale was essentially developed by selecting items from the Minnesota Multiphasic Personality Inventory and having them judged as to their meeting a clinical definition of chronic anxiety. A set of 65 items thus selected was combined with items representing non-chronic anxiety and administered to introductory psychology students. The original scale has undergone several modifications and various forms developed such as a scale for children. Representative items were as follows: "I work under a great deal or tension", "Life is a strain for me much of the time", and "I feel anxiety about something or someone almost all of the time."

A second scale of interest to the purpose of this paper was that developed by Zuckerman and others (Zuckerman, 1960). Their scale has been titled the Multiple Affect Adjective Checklist. The essential nature of the scale is a set of adjectives which the subject checks to describe how he or she feels. The adjectives themselves define three affective dimensions of anxiety, hostility, and depressions. The adjectives were selected on a rational basis and validated by contrasting high and low

groups on the three dimensions. One feature of the adjective check list given emphasis by Spielberger (1972) is the ability to measure both the state and trait nature of anxiety as set forth by Spielberger below.

The third approach to anxiety measurement to be given attention here is that proposed by Spielberger and his two dimensions theory of anxiety. He notes that there is a temporary condition which operates in a specific situation called "state" and a more permanent personality characteristic called "trait." The resulting inventory of a self-report, paper-pencil nature is the STAI or State-Trait Anxiety Inventory. The inventory consists of 20 items for each dimension with directions for answering related to a specific situation or a general condition. The items for the trait aspect were selected and included based upon their correlations with other scales such as the Taylor Manifest Anxiety Scale and the IPAT Anxiety Scale (Cattell and Scheier, 1963). For the trait scale, subjects responded to statements such as "I lack self-confidence" on a scale from Almost Never to Almost Always. These items were viewed as not being affected by situational stress and stable over time. For the state scale, the items were of the form "I feel calm", "I am tense", and subjects' responses on a scale from Not at all to Very Much So.

As noted, the three scales reviewed above are of the self-report variety which makes them suspect in terms of how subjects respond to them. The items may have different meanings for each person, individuals may not know themselves well enough to respond, or they might not be willing to admit their feelings. Spielberger feels however that such limitations can be and have been overcome in various research studies. Important to the purpose of this paper is that there has been a large amount of research

done using the scales, whatever their weaknesses. The development and subsequent research on the STAI has become the basis for many subsequent scale development efforts including those related to concepts such as test anxiety and math anxiety. Their use in the development and validation of scales proposing to assess feelings and emotions toward the computer will be evidenced in the next section reviewing the development of measures of computer anxiety.

Computer Anxiety Measurement

A search of information sources as ERIC reveals only a limited number of reports where the focus was on the development of measures of anxiety about using the computer. This section examines the set of studies available on the development and validation measures of computer anxiety. A subsequent section reviews research on the correlates of computer anxiety.

In examining the available literature, two approaches to anxiety measurement appear to exist. The first focuses upon the direct development of an index of computer anxiety which is then related to other variables. The second involves items on a survey of computer usage but which seek indirect responses from subjects regarding their fears or attitudes toward the computer. The studies of the former will be reviewed first and then followed by the other group.

Direct Indices There appear to be at the present writing three studies involving the direct development of a measure of computer anxiety. Each of these studies will be detailed below.

As part of an experimental study involving the use of computers in instruction, Raub (1981) developed an "Attitudes Toward Computers" scale

designed to assess anxiety, particularly the cognitive component of the response. Using a series of items derived from other sources, a set of 42 items was created of the form "When I think about computers, I feel anxious" and "I like to play games on a computer." After factor analysis, 25 items loading about .40 were selected for a final form. The scales was considered as unidimensional in that only one factor, label "Computer Anxiety" was identified. No data was presented on reliability. Raub interpreted the scale to be measuring a dichotomy with one pole indicating fear and mistrust of computers and the other pole indicating an appreciation of computers. Response terms were from Strongly Agree to Strongly Disagree.

To assess the emotional component, Raub developed an instrument identified as "Computer Usage Checklist." This consisted of a series of adjectives selected from the Zuckerman Affect Adjective Check List. An initial set of 65 words (e.g, active, calm, afraid, steady) was reduced through tryout to 37 with 14 being classified as anxiety plus, 12 as anxiety minus, 7 as describing helplessness, and 4 as representing hostility. In order to secure direct responses to the computer, the final instrument was administered to subjects as they sat at a terminal prior to instruction. The resulting scores were subsequently used to select six high anxious and three low anxious students for clinical interviews about their feelings. The structured interviews consisted of eight items designed to secure an additional sense of what individuals meant by "computer anxiety."

As part of the assessment of anxiety, the Trait-Anxiety scale developed by Spielberger was also utilized in the research. In view of the

experimental situation involving the teaching of statistics, the Mathematics Anxiety Scale (1972) was also included.

Undergraduate students were administered the four instruments as a battery twice during the spring semester 1981. An experimental group consisted of 29 students in an introductory course in COBOL while the control group consisted of 21 students in introductory psychology. The Attitudes Toward Computers Scale was used as a dependent variable with level of computer experience, trait anxiety, mathematics anxiety, and gender serving as independent variables in a repeated measurements ANOVA. The results of the analysis are presented in the subsequent section on correlates.

Building upon the increased use of computers in the classroom and teachers' potential anxiety about them, Rohner and Simonson (1981) initiated efforts to develop a measure of computer anxiety and relate it to selected variables. An initial decision was made to use a Likert type of scale because of its familiarity and data manipulation ease. A set of 63 statements reflecting cognitive components (21 items), affective components (22 items), and behavior (20 items) was created. The total set was reviewed by an "attitude expert" for face validity about computers in an educational environment. A pilot test of the items was administered to 32 teacher education students. After scoring, the lowest five students were considered a "positive" group and compared using item analysis procedures with the five highest scoring or "negative" students. Based upon the analysis, 10 items were selected that best discriminated the two groups. In order to avoid potential bias in responding, the 10 items were included with 20 additional distractor items on an "Educational Innovation Survey."

Items on computers that were included were of the form "Having a computer in my room would improve my instruction", "I look forward to use the time when computers are in all classrooms", and "My subject area is not appropriate for using the computer."

Reliability of the scale was determined by use of Cronbach's Alpha. The pilot test had a reliability of .88, and the final form a reliability of .86. A total of 175 students responded to the final form of the instrument. The performance on the computer anxiety measure (CAIN) was then related to selected variables deemed to reflect teachers' concerns about the introduction of innovation and change. These relationships are presented in the section on correlates. As for validity of the CAIN, the authors raise questions about what the scale is measuring. Obvious items such as "I feel anxiety about using computers" was eliminated in the pilot study becuse they did not discriminate. An attempt was made to secure validation by asking several educators identified as being highly computer anxious to take the scale. The results scores were variable and somewhat inconclusive. Through the use of informal interviews with these same persons, the authors feel that the instrument perhaps more accurately reflects "intent to use" computers than it reflects anxiety about using them. They suggest that additional research be conducted on computer anxiety in view of the increased use of computers.

Using the computer anxiety index developed by Rohner and Simonson as a starting point, Maurer (1983) proceeded to develop a revised form to overcome perceived limitations and to validate and set norms for a new form. Maurer believed that the original scale measured intent to use computers but not anxiety and that it was designed only for a limited

clientele -- those entering the teaching profession. The latter was remedied by rewording items to delete teaching references. In addition to changing the wording of items, new items were added by asking an intended audience, students in educational media, to create statements reflecting their feelings about using computers. These statements were modified into items and all items screened to make sure they dealt with anxiety. Two pilot tests were done to eliminate items that did not discriminate between those in the upper third and lower third of the score range. A final set of 26 items was retained to which respondents were to express level of agreement in Likert manner.

Validation of the index consisted of four actions. The CAIN was administered to students prior to use of a computer. The STAI was also administered to be a concurrent measure but at the moment students were actually to use a computer. A third part of validation was to observe the behavior of students actually using a computer with judgements being made about the level of computer anxiety exhibited. Two observers rated students on a three point scale from low to high computer anxiety. Reliability of the CAIN was determined by Cronbach's Alpha and by test/retest of the second pilot with the final form. The Alpha coefficient was found to be .94 for a randomly selected group not involved in the pilot test. The test/retest coefficient was .90 for items on both the pilot test and final form.

Using results from 111 students in undergraduate educational media classes, correlations between CAIN and the STAI and observation scores were obtained. The correlation between CAIN-STAI was .32 and CAIN-observation was .36 with both correlations significant at the .05 level.

Normative data was collected by administering the CAIN to five groups (computer users, computer professionals, junior high school students, public school teachers, and others not belonging to these groups) and obtaining mean scores. Sampling procedures were not systematically established. Score distributions were found to be positively skewed. College students were found to have the highest mean score and professionals the lowest.

Maurer noted that the validity coefficients, while significant, did not support identity of measurement between the anxiety measures. Partial explanation lies in the fact that STAI is a measure of general anxiety and not computer anxiety. Discrepancy between observation result and the CAIN was explained by the note that the former is considered an anxiety state measure while the other is an anxiety trait measure and thus are not identical. The author does believe that the results suggest that more work should go into developing a computer anxiety profile.

Indirect Measures In contrast to the above studies with their emphasis on self-report approaches, three studies were located that attempted to assess computer anxiety indirectly.

Powers, et al. (1973), as noted in the section on definitions, used physiological measures as indicators of anxiety. The study was initiated from a perspective that the presence of an anxiety level would interfere with learning about computer use. Using 18 paid male college level volunteer subjects divided into three groups based upon experience with computers, four physiological measures were taken at 13 time intervals over a two-hour period while using a specific computer program. The first time period was used to establish a base line. Changes between the second,

sixth and thirteenth time periods were subjected to within and between groups analyses. No significant differences on all variables were noted between the three groups from first to sixth period, between the sixth and thirteenth period, and the second and thirteenth period. Using a t-test for correlated measures for each group and for combined groups on the four physiological variables, significant increases were noted between the sixth period and first period, between the sixth and thirteenth, and the second and thirteenth periods at the .05 level. The authors note that the consistency was not as great for the second and thirteenth periods but that there was a significant decrease across the variables. A conclusion was drawn that continued exposure to computer usage reduces anxiety below a pre-exposure level. Commenting on the physiological measures used, the authors note that no single measure was sufficient to assess changes caused by anxiety. The electro-dermal response changes showed the greatest inconsistency. Reference is made in the report to a non-projective measure designed to reflect computer communication anxiety, however, no elaboration as to its nature or function was presented.

Stevens (1979) surveyed a random sample of 1,206 teachers from a population of 18,191 teachers and university faculty members and students to assess their knowledge and attitudes toward computers. The author noted the existence of the concept of computer anxiety but did not define it. Two items included on the survey asked if the individual "felt at ease when around computers" and "felt comfortable when others talked about computers." Respondents were asked to express level of agreement to the statements. The results showed that teachers expressed a higher level of anxiety regarding use of computers than did student teachers or teacher

educators. For all three groups, actually being around computers was less anxiety producing that talking about them.

In a manner similar to that of Stevens, Jordan and Stroup (1982) studied the attitudes of students before and after using the computer in an introductory data analysis course at the college level. Instead of the concept of anxiety, they utilized the concept of fear. Two items were included on a course survey given as a pre- and post-test over one semester. One item as it appeared on the pre-test form was worded as follows: "I am afraid to use computers" and then changed to "Now I am afraid to use computers" on the post-test. A second item on the post-test related to the prior item was "Before taking this course I was afraid to use the computer." Two other items on the post-test asked about then benefits of using the computer to understand the course content and if the computer work was enjoyable. Response format was Likert type with five positions from Strongly Agree to Strongly Disagree.

The responses to the item about fear on the pre-test was used to establish a grouping or dependent variable for a discriminant analysis on five independent variables. Three groups were established with one group indicating fear, a second not fearful and a third group indicating a middle position. In addition to the discriminant analysis, comparisons were made between fear feelings at the start of the course and upon completion of the course. Using a Wilcoxson matched pairs test, there was no statistically significant difference between pre-course fear and post-course memory of the early fear. A decrease in percent of students expressing fear to use the computer before and after the course from 22 to 12 percent. There was an increase in the percent of students indicating disagreement with the

statement "Now I am afraid to use the computer" from 58 to 80 percent. A signed ranks test for 69 matched pairs was significant indicating more disagreement for the post-test item. The results of the discriminant analysis on the five independent variable are summarized in Table 1 and discussed in the section below on Correlates.

Summary

This section has examined, albeit briefly, the efforts made to measure anxiety in general. Several studies dealing with the development of measures specifically focused on computer anxiety were reviewed in detail. Based upon the several studies, several generalizations regarding the measurement of computer anxiety in terms of its present state-of-the-art can be made. Listed below are the principal points that seem to be substantiated:

1. The main approach has been to use some form of paper-pencil self-report format in contrast to using indirect measures such as blood pressure.

2. The basic model for many instruments has been that developed in connection with the State-Trait Inventory developed by Spielberger and others.

3. Likert scale formats are most often used with three to five categories usually of the agree-disagree response form.

4. Items or statements are generally developed from some rational definition of computer anxiety, subject to some form of face validity check, and then administered as a pilot test.

5. Final item sets are established based upon some form of item analysis comparing high and low scoring groups.

6. Reliability is typically approached by using form of internal consistency such as Cronbach's Alpha.

7. Reliability coefficients tend to be in the upper range locating around .80 or above.

8. Validity of such measures is somewhat difficult to establish. Validation often approached by relating computer anxiety scores to variables assumed to reflect anxiety or to know measures such as the STAI noted above.

9. The present state-of-the-art suggests that the concepts of computer anxiety, if existing, are somewhat difficult to measure validly, but what is measured can be done so reliably.

CORRELATES OF COMPUTER ANXIETY

In the course of assessing measures of computer anxiety, researchers whose studies were reviewed for this paper investigated potential correlates. The results of these studies are presented in Table 1.

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Powers, et al. (1973) investigated the relationship between prior computer experience and changes in four physiological measures over a two-hour period of computer use. They found a relationship between exposure to computer terminal use and changes in basic physiological activity, which was defined as computer anxiety, regardless of prior computer exposure. Furthermore, they found a significant decrease in

TABLE 1. CORRELATES OF COMPUTER ANXIETY

INVESTIGATOR/DATE	SUBJECTS AND ANALYSIS	CRITERION-ANXIETY	INDEPENDENT VARIABLES	RESULTS
Powers, et al. (1973)	Paid male volunteer college subjects (N=18); between and within groups analysis	Three groups on basis of computer experience	Changes in systolic and diastolic BP, heart rate, and skin response over two-hour period of use	1. No significant difference between groups on changes in all variables 2. Significant increase between 6th and 1st (base) periods; between 6th and 13th periods (within groups) 3. Significant decrease between 2nd and 13th periods
Raub (1981)	College students - introductory psychology, computer, math, stat courses (N=270); multiple regression analysis by sex	Total score on attitudes toward computers questionnaires (Likert scale)	1. Males [F (2,119)=28.01 p=.001 (N=122)] experience level plus trait anxiety 2. Females [F (2,95)=13.37 p=.001 (N=98)] experience level plus math anxiety 3. College major, mother and father's education - not significant	R^2=.22 and R^2=.32 R^2=.18 and R^2=.21
Rohner and Simonson (1981)	College level teacher education students (N=175); Pearson correlation coefficients; ANOVA	Attitudes toward computers and computer use in classroom; five-point (Likert scale) intent to use measure	1. SOLAT (hemisphericity) 2. CEFT (field dependence, independence) 3. Gender 4. College major	r=-.122 .059 r=-.100 .251 r=-.009 .454 F= 1.58 .18
Jordan and Stroup (1982)	College level intro data analysis course (N=124); discriminant function and pretest difference	Two groups - hi and low on two-item Likert scale as pretest on fear of computer use	1. Sex 2. Self-report on problem-solving style (analytical vs. heuristic) 3. GPA 4. SAT quantitative 5. SAT verbal	Univariate / Wilks-Lambda / Signif. F=2.65 / .94 / .08 F=2.59 / .89 / .04 F=2.29 / .85 / .04 F=2.22 / .81 / .03 F= .02 / (not entered) /
Maurer (1983)	College students teacher education (N=111); validation and norming of CAIN	CAIN - hi/low scores; six-point scale ag.-dis. observations	1. STAI (state anxiety) 2. Observed rating of behavior	.32 .01 .36 .01

anxiety as a function of utilization of the computer terminal. They qualify their results by suggesting that a portion of the anxiety indicated in advanced computer experience subjects may be due to the methodological demands of the experiment which required the manipulation of an unfamiliar program.

Raub (1981) conducted a multiple regression analysis with computer anxiety as the dependent variable and trait anxiety, math anxiety, level of computer experience, gender, age, college major, mother's education and father's education as the independent variables. Since the variables represented a combination of interval and categorial scales, three preliminary data analysis techniques were employed to justify the inclusion of the variables in the regression analysis.

Scattergrams were used to determine the linearity between the dependent variable and age and computer experience. No linear relationship was found between computer anxiety and age, therefore, age was eliminated from the multiple regression. It should be noted, however, that Raub's sample included a limited age range of 17 to 21 years of age. A negative relationship was found between computer experience and computer anxiety, therefore, computer experience was entered into the regression analysis.

A preliminary multiple regression was performed to determine the contribution of math anxiety and trait anxiety to the criterion of computer anxiety. Both variables contributed significantly [$F(2.217)=12.31$, $p<.001$.], so both were entered into the second multiple regression.

A four-way ANOVA was conducted to determine whether college major, mother's education, father's education, and gender should be included in the multiple regression equation. Based on the result, Raub concluded that

only gender warranted inclusion.

Separate analyses were subsequently performed for the male and female samples. Level of computer experience and trait anxiety were identified as significant contributors to computer anxiety for males, while computer experience and math anxiety were significant contributors to computer anxiety for females.

Rohner and Simonson (1981) explored correlations between the Computer Anxiety Index (CAIN) and sex, hemisphericity, field dependence-independence, and college major. Hemisphericity was measured by the "Your Style of Learning and Thinking Test" (SOLAT) developed by E. Paul Torrance at the University of Georgia. Field dependence-independence was measured by the "Group Embedded Figures Test" (GEFT). They found no statistically significant differences, though a possible trend was indicated between computer anxiety and hemisphericity. The correlation of -.1215 at the .059 level of significance suggested that there was a tendency for left-brain dominants to have more computer anxiety than right-brain dominants. This was consistent with reported studies which indicated a similar relationship between hemisphericity and proneness to general anxiety.

Recall from the earlier discussion of the Rohner and Simonson study that the CAIN seems to be a measure of intent to use rather than of computer anxiety as a construct. The authors suggest that it probably measured anxiety as one factor that inhibits the intent to use. This confusion about what the instrument actually measures naturally raises questions about the interpretability of the correlated data in terms of computer anxiety as defined in this paper.

Jordan and Stroup (1982) related self-reports of fear of computer use

to grade point average, SAT verbal and quantitative scores, sex and self-identification as an analytical problem-solver, a heuristic problem-solver, or an intuitive problem-solver. Of the five independent variables used in the analysis, sex was found to have the strongest discriminating influence on computer fearfulness, followed by self-identification as an analytical problem-solver, G.P.A. and the SAT quantitative score. SAT verbal was not entered into the equation because it failed to meet the minimum criterion of an F-ratio greater than 1.0.

As noted in the previous section of this paper, Jordan and Stroup also noticed a decrease in reported fear of computers after exposure.

As part of validation procedures for modification of the CAIN, Maurer (1983) correlated the CAIN with two other measures of computer related anxiety. The first was the STAI, a general measure of state-trait anxiety discussed earlier in this paper. The STAI was adminsitered while subjects were sitting before a microcomputer which they were expecting to use momentarily. Subjects showing relatively high levels of state anxiety on this measure were considered to be showing relatively high levels of computer anxiety. The correlation was .32, significant at the .01 level.

The second correlation which Maurer investigated was observed computer anxiety behavior. Two independent observers, the experimenter and the students' regular teacher, watched the students as they participated in a regular classroom session in which they were required to use the microcomputer. Four behaviors were judged to be overt signs of computer anxiety:

1. Avoidance of the computer and the general area where the computer was located.

2. Excessive caution with the computer.

3. Negative remarks about the computer.

4. Attempts to cut the computer sessions short.

Subjects were scored as either low computer anxious, neutral, or high computer anxious. Correlation with CAIN was .36, significant at the .01 level.

Summary

Since each of the studies reviewed for this paper tends to approach the issue of computer anxiety correlates from a different perspective, it is difficult to generalize or even to speculate about trends in this regard. Keeping all necessary caveats in mind, the following observations are offered as possible areas for further research. This is not to say that variables not mentioned should be ignored or that new correlates should not be explored to further an understanding of computer anxiety.

1. Gender was used as an independent variable in three of the five studies. Two of the three (Jordan-Stroup, Raub) reports relationships between gender and their measures of computer anxiety. This would seem to be an obvious area for further study.

2. Two studies (Raub, Maurer) explored the relationship between computer anxiety and state-trait anxiety. While both agree that computer anxiety seems to be a state anxiety brought about by exposure to computer use, Raub did find a correlation in his male subjects between trait anxiety and computer anxiety. The relationships between CA and state and trait anxiety need to be explored further and classified if computer anxiety is to be defined accurately.

3. The indication of a possible relationship between hemisphericity

and computer anxiety warrants a closer look. This relationship may be explained by what some researchers have found to be a predominance of left hemisphericity dominance among females.

CONCLUSION

This paper described the research to date on the measurement of computer anxiety and its correlates. Five studies were identified that pertained to the topic. These studies were analyzed for their contributions to an understanding of the phenomenon: its definition, measurement and correlates. With one exception, the studies tended not to build upon one another, though most were related to general anxiety theory. It is clear from this preliminary review that more work must be done to determine if computer anxiety is a valid psychological construct and, if it is, how it should be defined, measured and correlated with other known variables.

REFERENCES

Betz, N.E. Math anxiety: what is it? Paper presented at the Annual Convention of the American Psychological Association, San Francisco, California, August 26-30, 1977. ERIC Doc. No. 149 220.

Cattell, R.B. and Scheier, I.H. The meaning and measurement of neuroticism and anxiety. New York: Ronald Press, 1961.

Cattell, R.B. and Scheier, I.H. The nature of anxiety: a review of thirteen multivariate analyses comprising 814 variables. Psychological Reports. 1958, 4, 351-388.

Epstein, S. The nature of anxiety with emphasis upon its relationship to expectancy. In C.D. Speilberger (ed), Anxiety: current trends in theory and research (Vol II). New York: Academic Press, 1972.

Jordan, E.W. & Stroup, D.F. The behavioral antecedents of computer fear. Journal of Data Education, 1982, 22, 7-8.

Mandler, G. & Sarason, S.B. A study of anxiety and learning. Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

Maurer, M.M. Development and validation of a measure of computer anxiety. Unpublished master's thesis, Iowa State University, 1983.

May, R. The meaning of anxiety. New York: Ronald Press, 1950.

Phillips, B.N., Martin, R.P. and Meyers, J. Interventions in relation to anxiety in school. In C.D. Spielberger (ed), Anxiety: current trends in theory and research (Vol. II). New York: Academic Press, 1972.

Powers, W.G. et al. The effects of prior computer exposure on man-machine computer anxiety. Paper presented at the International Communication Association Convention, Montreal, Canada, April 25-28, 1973. Eric Doc. No. 089 763.

Raub, A.C. Correlates of computer anxiety in college students. Unpublished doctoral dissertation, University of Pennsylvania, 1981.

Resnick, H., Viehe, J. and Segal, S. Is math anxiety a local phenomenon? A study of prevalence and dimensionality. Journal of Counseling Psychology, 1982, 29, 39-47.

Richardson, F.C. and Suinn, R.M. The mathematics anxiety rating scale: psychometric data. Journal of Counseling Psychology, 1972, 19, 551-554.